

3 1761 11632072 2

CALL NO.
CA1
BS 112
-71P12
GOVT

Canada. Statistics Canada.

CANADA
DOMINION BUREAU OF STATISTICS
CENSUS DIVISION

Government
Publications

Reprinted Publication No. 12

ESTIMATION OF INTERPROVINCIAL MIGRATION FOR CANADA
FROM PLACE OF BIRTH BY RESIDENCE DATA, 1951-1961

by

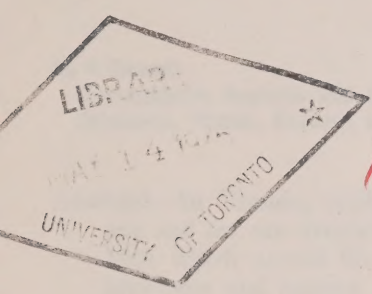
M.V. George

Printed from Demography 8(1, February 1971), 123-139.

CA1
BS 112
P12

Canada. Statistics Canada.
CANADA
DOMINION BUREAU OF STATISTICS
CENSUS DIVISION

Government
Publications



Reprinted Publication No. 12

ESTIMATION OF INTERPROVINCIAL MIGRATION FOR CANADA
FROM PLACE OF BIRTH BY RESIDENCE DATA, 1951-1961

by

M.V. George

Reprinted from Demography 8(1, February 1971), 123-139.



Digitized by the Internet Archive
in 2023 with funding from
University of Toronto

<https://archive.org/details/31761116320722>

ESTIMATION OF INTERPROVINCIAL MIGRATION FOR CANADA FROM PLACE OF BIRTH BY RESIDENCE DATA, 1951-1961

M. V. George

Demographic Analysis and Research Section, Census Division, Dominion Bureau of Statistics, Ottawa, Canada, and Department of Sociology, University of Ottawa

Abstract—In Canada, unlike many other countries, birth-residence data by age and sex are available in each of the decennial censuses from 1931 to 1961 which permit the estimation of intercensal net migration for the provinces and regions. After a brief discussion of the basic measures of migration from birth-residence data the paper focusses on the problems and procedures in estimating interprovincial net migration, 1951-1961 for Canada using "the place of birth survival ratio method," and it evaluates the estimates thus obtained. The evaluation of the estimates, taking into consideration the inherent limitations of the method and its merits compared with period migration estimates by the census survival ratio method and life table survival ratio method, suggests that the net migration estimates for the Canadian born by the place of birth survival ratio method are probably more reliable than those by the other two methods. One striking finding was that the net migration curves by age obtained from the census survival ratio and place of birth survival ratio estimates were smoother than the curve obtained with the use of the more accurate life table survival ratios. Furthermore, whatever the relative accuracy of net migration may be, the birth-residence approach is capable of furnishing more details about the net migration of the native born than by the standard survival-ratio methods. For the population under age 10 intercensal estimates were directly derived from the place of birth and residence distributions by age.

Statistics of persons classified jointly by place of birth and residence and tabulated by age and sex for the same set of areal units at successive censuses are seldom available to make full use of place of birth data for estimating intercensal migration. In Canada, unlike many other countries, place of birth data by age and sex are available in each of the decennial censuses from 1931 to 1961 which permit the estimation of intercensal net migration by age and sex for provinces and regions. This paper discusses the problems and procedures in estimating intercensal net migration for the provinces of Canada, 1951-1961,

using the "place of birth survival ratio method," and it compares migration estimates thus obtained with other estimates based on survival ratios for the same period. Migration estimates for other decades using the same procedure are made in a recent monograph by the writer (George, 1970).

1. THE BASIC MEASURES OF MIGRATION FROM PLACE OF BIRTH DATA

The basic measures of migration from place of birth data and the superiority of migration estimates from place of birth data over estimates by the census survival ratio method are discussed in a

number of studies and need not be repeated in detail (See Lee, 1957, pp. 57-64; Zachariah, 1964, C. III; Eldridge, 1965a, C.V.). Replies to the place of birth question divides the population into two major components, those enumerated in the place of birth, the "non-migrants;" and those enumerated outside the place of birth, the "migrants." From these data it is possible to estimate the migration flows into and out of provinces or other spatial units depending on how the data are collected and tabulated. In terms of place of birth data available for Canada, for example, a person is a migrant if he is enumerated in a province other than his province of birth. Thus, within the limitations of that definition, the following migration measures can be derived: (i) the lifetime in-migrants to the province (I); (ii) the lifetime out-migrants from the province (O); and (iii) the lifetime net migration in the province or the "birth residence index" ($M = I - O$).

The above migration indices, in-, out-, and net migration, however do not refer to any specified time period. These are lifetime migration indices which represent the survivors of persons who have migrated out of the province of birth and the return migrants, i.e., those returned to the province of birth from the province of residence at anytime since they were born. Thus, the place of birth data relate to the surviving lifetime migrants and not to gross migration and they refer to the date of the census and not to any specific period preceding the census. A partial solution of this problem is the estimation of intercensal net migration.

2. METHOD OF ESTIMATING INTERCENSAL NET MIGRATION

The simple procedure to estimate intercensal net migration is to subtract the place of birth information for the earlier census from that for the later census. Thus, for example, if I_1 , O_1 and M_1 are the in-, out-, and net lifetime migrants,

respectively at the first census in province A , and I_2 , O_2 , and M_2 are the corresponding lifetime migrants in the second census, then an estimate of net migration (M) for A during the intercensal period is given by:

$$M = (I_2 - O_2) - (I_1 - O_1) \quad \text{or} \quad M_2 - M_1. \quad (1)$$

There are two components of net-migration in this estimate which can be separated. They are: (i) intercensal net-migration among persons born outside the province ($I_2 - I_1$), and (ii) the intercensal net-migration among persons born in the province concerned ($O_2 - O_1$). The difference between the two components also gives the intercensal net-migration. Thus,

$$\text{Net } M = (I_2 - I_1) - (O_2 - O_1). \quad (2)$$

The same formula may be written as:

$$\text{Net } M = (I_2 - I_1) + (O_1 - O_2). \quad (3)$$

The above method for estimating intercensal net migration is subject to errors in the basic data, and "errors" caused by mortality, return migration, multiple movements and international migration (the term "error" in this context refers to the extent to which the above procedure fails to estimate intercensal net migration from place of birth statistics). In the case of migration between a province and two or more other provinces, there is an additional shortcoming because of the failure to identify the circular movements. For example, if a person born in province A moves to province B and then to C during an intercensal period, he will appear as a case of direct movement from province A to province C , and thus the procedure fails to identify the movement from province B to C .

In addition to the above limitations in the migration estimates derived from the place of birth data, the errors in the reporting of place of birth information

should be kept in mind while interpreting the results. Although the place of birth information is a fundamental fact in life, if the information is given by another person, especially when date of birth is rather removed in time from the census date, the probability of inaccurate information may increase. When comparing figures based on this information, it is thus implicitly assumed that the degree of correctness is identical in all provinces of residence for all provinces of birth and of the same magnitude in the successive censuses. Further, sometimes, cases of "spurious" migration must be assumed to be included among these figures, for example, when someone has been born in a hospital just across the border of a province. Such persons not born at the usual province of residence of their parents become migrants according to the place of birth data. It may be noted, however, that even if the estimates of lifetime in-migration and lifetime out-migration are in error because of the misstatement of place of birth information, the estimates of lifetime net migration need not be in error because errors cancel out in net migration estimates. Also, even if there is error in the estimates of net lifetime migration, the estimates of intercensal net migration can be free from the error if the absolute errors in the place of birth data for the two successive censuses are of the same magnitude and of the same direction.

The estimates using formulas (1), (2) and (3) give only an estimate of the number of surviving intercensal net migrants and not an estimate of total intercensal net migration. The most serious error in the estimation of intercensal migration by this method is caused by mortality (See Lee, 1957, pp. 57-64; Zachariah, 1964, C. III; Shryock, Jr., 1964, Appendix A; George, 1965, C. III). The studies cited assume that the population is not affected by external migration of the natives (Canadian born) but

this is not true for Canada where substantial migration of native born takes place between Canada and the United States for which special adjustments of native-born population are required. The effect of mortality on the estimate of net migration during the intercensal period can be assessed easily by studying separately its effect on the estimates of intercensal net in-migration ($I_2 - I_1$) and net out-migration ($O_2 - O_1$). In order to illustrate this, migration between Ontario and all other provinces together is considered. Also, it is assumed that there are no errors in basic data and there is no international migration among Canadian born during the intercensal period.

The number of life-time in-migrants to Ontario at the second census, I_2 , is equal to:

$I_2 = I_1$ minus deaths among I_1 during the intercensal period: $(1 - S)(I_1)$ plus surviving in-migrants to Ontario during the intercensal period who were enumerated in the second census: SM_i
minus portion of the survivors among I_1 , who moved out from Ontario before the second census:
 $(1 - p)SI_1$.

Therefore

$$I_2 = I_1 - (1 - S)I_1 + SM_i - (1 - p)SI_1,$$

where S is the overall intercensal survival ratio (this refers to the total population and not to any age group) applicable to the in-migrants to Ontario (I_1); and p is the proportion of surviving in-migrants among I_1 , who were enumerated at the second census.

The difference $I_2 - I_1$ as an estimate of intercensal net in-migration to Ontario is in error by the amount— $(1 - S)I_1 - (1 - p)SI_1$. This is equal to the deaths among in-migrants who came to Ontario at any time before the first census and

the return migration among I_1 . Whatever the magnitude of error due to return migration may be, it is not possible to correct this. If adjustment is made for the deaths among I_1 , the intercensal net in-migration estimate will be:

$$(I_2 - SI_1) = SM_i - (1 - p)SI_1.$$

The number of out-migrants from Ontario enumerated in the second census will be:

$O_2 = O_1$ minus deaths among O_1 during the intercensal period: $1 - S$ (O_1) plus surviving out-migrants from Ontario during the intercensal period who were enumerated in the second census: SM_0 minus the portion of the survivors among O_1 who returned to Ontario before the second census: $(1 - p)SO_1$.

Therefore,

$$O_2 = O_1 - (1 - S)O_1 + SM_0 - (1 - p)SO_1.$$

The difference $O_2 - O_1$ as an estimate of intercensal net out-migration from Ontario is in error by the amount— $(1 - S)O_1 - (1 - p)SO_1$. This is equal to the deaths among out-migrants who moved out from Ontario at any time before the first census and the return migration among O_1 . If adjustments for deaths among O_1 is made the intercensal net out-migration estimate will be:

$$(O_2 - SO_1) = SM_0 - (1 - p)SO_1.$$

Putting the two components together, I and O , the estimate of the intercensal net migration to Ontario ($I_2 - I_1$) — ($O_2 - O_1$) can be obtained. Thus:

$$(I_2 - I_1) - (O_2 - O_1)$$

$$= -(1 - S)I_1 + (1 - S)O_1 - (1 - p)SI_1 + (1 - p)SO_1 + SM_i - SM_0.$$

The correct estimate of intercensal net migration to Ontario according to the place of birth data is $SM_i - SM_0$ (the difference between surviving in-migrants and surviving out-migrants), the other terms being error components due to the effect of mortality and return migration. If adjustment is made for mortality among I_1 and O_1 , the intercensal net migration estimates may be free from the major source of error and the estimate will be affected only by the factor of return migration. Although it is difficult to make any adjustment for the factor of return migration because of the non-availability of required data, there is every possibility for at least a part of this error being cancelled out in the estimation of intercensal net migration. If $(1 - p)SI_1$ and $(1 - p)SO_1$ are of equal value, the intercensal net migration estimates will be free from this error.

It is fairly clear from the preceding discussion that in the estimation of intercensal migration using equation (1) under the two assumptions stated, the most serious error is caused by mortality. All those among I_1 and O_1 groups who die during the intercensal interval will appear as "fresh migrants" if estimates are made without mortality corrections. The data required for fairly refined mortality corrections are the place of birth data by residence cross-classified by age and sex for successive censuses and appropriate age-specific survival ratios. In situations where the required data for refined mortality corrections are not available, an overall survival ratio (ratio of persons aged n years and over in the country at the second census at time $t + n$ to persons of all ages in the first census at time t , i.e., P_{n+t+n}/P_t under the assumption of a "closed" population) or the overall life table survival ratio (T_n/T_0) cal-

culated from a life table covering the period may be used. Thus, in the absence of place of birth-residence data by age, migration for all ages together with mortality correction (\bar{M}) will be:

$$\bar{M} = (I_2 - O_2) - S(I_1 - O_1).$$

The required birth residence data cross-classified by age and sex are readily available for each of the provinces of Canada in the decennial censuses since 1931 for estimating intercensal net migration from these data. Assuming that the native-born population is reasonably "closed" (i.e., not affected by international migration), it is possible to calculate provincial intercensal age-specific census survival ratios for the population born in a province (in-born), including both those living in the province and those living elsewhere at each census date. By applying such survival ratios to the population born in a province and residing there and in each of the other provinces in the first census, expected numbers of this population for the second census can be obtained. The difference between the expected numbers and the corresponding numbers enumerated in the second census are estimates of net change due to the intercensal migration of population born in each province with reference to each of the 11 provinces (including Newfoundland, and taking Yukon and Northwest Territories as one province). By repeating this operation for each province, net change due to migration of in-born population of each province can be estimated for that province and each of the other 10 provinces. From these can be accumulated, for each province, the intercensal net migration by age and sex of population born in each province (in-born), which is usually net out-migration, and the net migration of population born outside the province (out-born), which is usually net in-migration. The sum of these two represents the net migration for the province. The details of

the computational procedures are explained in Eldridge and Kim (1968) and George (1970, Appendix B).

3. ADJUSTMENTS FOR THE OPEN NATURE OF THE CANADIAN-BORN POPULATION

As mentioned earlier, a "closed" population is a condition to calculate the survival ratios of the in-born by age and sex for each province. Because the place of birth method is used only to estimate the intercensal net migration of the Canadian born, adjustments are to be made only for external migration of this group. Although separate records of the external movements of the Canadian born do not exist, there is enough evidence to show that the majority of Canadian-born emigrants went to the United States. According to the U. N. Demographic Year Book 1963, of the total number of Canadian-born emigrants enumerated in other countries in the 1960's, about 93 per cent were enumerated in the United States. It was therefore assumed that the native-born population enumerated in Canada and the United States together would make a reasonably closed population for the purpose here and on this assumption, the numbers of the Canadian born enumerated in the U. S. censuses in 1950 and 1960 were added to the corresponding numbers enumerated in Canada in 1951 and 1961, respectively. Because there is a difference of 11 months between the United States census date and the Canadian census date, figures of the Canadian born enumerated in the United States censuses and in the Canadian censuses do not take into account the flows of the Canadian born between the two countries and their deaths during the periods of 11 months at both ends of the intercensal intervals. No special adjustment of the data has been made for the possible double counting and/or undercounting arising from this difference of 11 months. Because the flows between the United States and Canada are in

both directions, and the number involved is likely to be small, it is reasonable to assume that much of the limitations of the data on account of this source cancel out to a considerable extent.

Another problem was that in 1960 the Canadian-born population enumerated in the United States censuses was not given in five-year age groups. After trying several methods, it was decided to distribute the given population distributions in 1960 into five-year age groups (without affecting the numbers in given age groups) on the basis of the age distributions of the foreign-born population enumerated in Canada in 1961. A comparison of the given age distributions of the Canadian born in the United States in 1950 and 1960 showed that they were strikingly similar to the corresponding distributions of the foreign born enumerated in Canada. Keyfitz (1950) also observed such similarity for the years 1910 and 1930 and used the same procedure in his study. The proportion of the Canadian born enumerated in the United States to the total Canadian-born population was 7.7 per cent in 1950 and 5.8 per cent in 1960.

In the United States censuses, the Canadian born were not given by province of origin, which created the problem of thus distributing them. However, except in 1960 the number of Canadian-born persons living in the United States were classified as being of French or non-French origin, which helped to make possible fairly reasonable proportional distributions. The people of French origin in Canada are concentrated in Quebec, Ontario and New Brunswick in which provinces the percentage distributions in 1961 were 76.8, 11.6 and 4.2, respectively. Hence, separate distributions of Canadian-born people of French origin and non-French origin were made only for these three provinces calculated as follows: (i) population of French origin by age and sex in the United States in each census was distributed according

to the corresponding proportion of the population of French origin in Quebec, Ontario and New Brunswick to the total population of French in Canada; (ii) the remaining portion of population of French origin was merged with the population of non-French origin living in the United States and distributed according to the ratios of population of non-French in each province (assuming the total population as being non-French in all the provinces except the three mentioned) to the total non-French in Canada; and (iii) the separate figures of French and non-French origins estimates for Quebec, Ontario and New Brunswick were combined to obtain the total distribution of the Canadian born in each of them. Although there is no adequate statistical or empirical evidence to prove the validity of the pro rata distribution used here, the analysis of the flow of in- and out-migration in Canada and the United States indicates a positive association between in- and out-migration rates (Kasahara, 1963, p. 27; Shryock, 1964, pp. 194 and 195).

The estimated age-sex distributions of Canadian born enumerated in the U. S. censuses by province of origin were finally added to the corresponding Canadian-born populations of each province. The resulting totals for each gave a reasonably closed population of native born for each province in 1951 and 1961. In pooling the data on the Canadian-born population as described, it was also assumed that the patterns of errors of enumeration were the same in the Canadian and the U. S. censuses.

Using the estimated in-born population distributions, the intercensal survival ratios of the native born for each province for the period 1951-61 were calculated as explained in Section 2. (These ratios appear in George, 1970, Table 3.3.) The survival ratios for five-year age groups should normally increase up to the age group 5-9 and then decrease gradually with increasing age.

The calculated survival ratios not only deviate from this normal pattern, but also exceed unity for some age groups. Such a deviation from the normal pattern of survival ratios may be due to the separate or combined effect of (i) errors in age reporting; (ii) under-enumeration or over-enumeration; (iii) misstatement of place of birth either at the initial or terminal censuses; and (iv) errors in the adjustment of the data for international migration of the Canadian-born population. In most cases, survival ratios for ages 0-4 to 10-14 are greater than unity suggesting appreciable under-enumeration of children in the age group 0-4. Also, in most of the provinces, the ratios are greater than unity for the age groups 25-29 to 35-39 and 30-34 to 40-44, sug-

gesting again appreciable under-enumeration in the most mobile age groups 25-29 and 30-34 which seems to be more in the 1951 census than in 1961, or some systematic bias in the reporting of ages. These survival ratios were applied to the appropriate age-sex and residence distributions of the in-born population of each province (enumerated in the province and outside), and estimates of the intercensal net migration of in-born, out-born and the net balance (sum of the two) for each province were obtained by subtraction of expected from observed numbers. The results are given in Table 1.

4. ALTERNATE PROCEDURE

According to the procedure used in the

TABLE 1.—Net Migration of In-born and Out-born and Net Balance of Interprovincial Migration of Canadian Born Aged 10 and Over, by Age and Sex, 1951-61.

Age in 1961	Newfoundland			Prince Edward Island			Nova Scotia		
	In- born	Out- born	Net balance	In- born	Out- born	Net balance	In- born	Out- born	Net balance
MALES									
10 - 14	-1,256	196	-1,060	- 727	64	- 663	- 4,087	1,238	- 2,849
15 - 19	-1,019	105	- 914	- 517	- 18	- 535	- 3,351	2,014	- 1,337
20 - 24	-2,439	522	-1,917	-1,344	246	-1,098	- 6,365	4,248	- 2,117
25 - 29	-1,938	554	-1,384	-1,334	232	-1,102	- 5,857	1,931	- 3,926
30 - 34	- 666	216	- 450	- 595	- 98	- 693	- 2,228	- 421	- 2,649
35 - 39	- 721	118	- 603	- 310	-114	- 424	- 1,887	- 232	- 2,119
40 - 44	142	96	238	- 165	- 72	- 237	- 603	- 78	- 681
45 - 49	182	37	219	- 66	- 16	- 82	- 246	- 75	- 321
50 - 54	- 118	22	- 96	- 90	- 14	- 104	- 554	- 112	- 666
55 - 59	- 118	19	- 99	- 14	4	- 10	- 135	- 44	- 179
60 - 64	- 66	- 14	- 80	65	13	78	30	31	61
65 - 69	17	- 9	8	63	8	71	168	- 95	73
70+	133	- 24	109	93	3	96	479	59	538
Total, 10+	-7,867	1,838	-6,029	-4,941	238	-4,703	-24,636	8,464	-16,172
FEMALES									
10 - 14	-1,120	219	- 901	- 707	62	- 645	- 3,868	1,113	- 2,755
15 - 19	-1,084	53	-1,031	- 589	- 20	- 609	- 3,022	706	- 2,316
20 - 24	-2,097	314	-1,783	-1,460	166	-1,294	- 6,153	1,717	- 4,436
25 - 29	-2,222	417	-1,805	-1,562	205	-1,357	- 6,541	1,705	- 4,836
30 - 34	-1,187	229	- 958	- 737	57	- 680	- 3,534	797	- 2,737
35 - 39	- 764	52	- 712	- 352	- 64	- 416	- 2,155	169	- 1,986
40 - 44	79	5	84	- 95	- 33	- 128	- 364	95	- 269
45 - 49	103	33	136	- 51	- 7	- 58	- 238	25	- 213
50 - 54	- 269	27	- 242	- 51	- 3	- 54	- 603	- 117	- 720
55 - 59	- 155	15	- 140	- 42	9	- 33	- 94	4	- 90
60 - 64	- 99	- 9	- 108	- 11	- 4	- 15	- 88	- 17	- 105
65 - 69	- 150	- 6	- 156	4	- 6	- 2	93	17	110
70+	- 220	- 4	- 224	2	13	15	308	148	456
Total, 10+	-9,185	1,345	-7,840	-5,651	375	-5,276	-26,259	6,362	-19,897

TABLE 1.—Continued

Age in 1961	New Brunswick			Quebec			Ontario			Manitoba		
	In- born	Out- born	Net balance	In- born	Out- born	Net balance	In- born	Out- born	Net balance	In- born	Out- born	Net balance
MALES												
10 - 14	- 3,107	1,288	- 1,819	- 6,018	3,784	- 2,234	-11,627	10,986	- 641	- 5,049	2,228	- 2,821
15 - 19	- 2,353	948	- 1,405	- 3,992	2,092	- 1,900	- 5,576	8,135	2,559	- 2,430	1,108	- 1,322
20 - 24	- 5,473	1,699	- 3,774	- 6,989	4,382	- 2,607	- 9,884	14,258	4,374	- 3,735	2,685	- 1,050
25 - 29	- 5,336	1,508	- 3,828	- 7,804	5,142	- 2,662	- 9,742	13,699	3,957	- 4,634	2,575	- 2,059
30 - 34	- 2,203	859	- 1,344	- 4,186	3,087	- 1,099	- 5,245	4,956	- 289	- 3,132	880	- 2,252
35 - 39	- 1,507	456	- 1,051	- 2,947	1,306	- 1,641	- 6,620	2,687	- 3,933	- 2,520	420	- 2,100
40 - 44	- 732	298	- 434	- 2,157	1,057	- 1,100	971	3,091	4,062	- 894	279	- 615
45 - 49	- 337	99	- 238	- 2,231	397	- 1,834	1,222	2,013	3,235	- 762	135	- 627
50 - 54	- 452	- 17	- 469	- 700	137	- 563	- 2,114	623	- 1,491	- 525	- 68	- 593
55 - 59	- 26	1	- 25	1,328	- 58	1,270	- 571	232	- 339	- 136	- 115	- 251
60 - 64	110	- 11	99	617	- 454	163	- 1,005	- 16	- 1,021	46	- 58	- 104
65 - 69	201	27	228	407	- 263	144	8	16	8	51	- 150	- 99
70+	261	86	347	2,273	136	2,409	1,021	545	1,566	539	- 384	155
Total, 10+	-20,954	7,241	-13,713	-32,399	20,745	-11,654	-49,178	61,225	12,047	-23,273	9,535	-13,738
FEMALES												
10 - 14	- 3,057	1,259	- 1,798	- 5,663	3,331	- 2,332	-11,064	10,463	- 601	- 4,531	2,318	- 2,213
15 - 19	- 2,565	606	- 1,959	- 3,663	2,553	- 1,110	- 5,430	7,526	2,096	- 2,487	1,061	- 1,426
20 - 24	- 5,465	1,283	- 4,182	- 6,436	5,435	- 1,001	- 9,482	14,569	5,087	- 4,325	2,580	- 1,745
25 - 29	- 5,741	1,191	- 4,550	- 9,187	5,770	- 3,417	-12,937	15,881	2,944	- 5,889	2,241	- 3,648
30 - 34	- 3,024	626	- 2,398	- 7,089	2,829	- 4,260	- 9,261	9,128	- 133	- 4,073	628	- 3,445
35 - 39	- 1,787	297	- 1,490	- 4,508	1,209	- 3,299	- 7,950	4,405	- 3,545	- 2,860	000	- 2,860
40 - 44	- 532	270	- 262	- 2,246	245	- 2,001	- 2,186	3,645	5,831	- 731	185	- 546
45 - 49	- 327	62	- 265	- 1,178	491	- 687	1,957	2,741	4,698	- 545	49	- 496
50 - 54	- 479	- 11	- 490	- 690	- 1	- 691	- 2,467	1,236	- 1,231	- 538	- 159	- 697
55 - 59	9	14	23	854	- 80	774	- 675	655	- 20	- 283	- 57	- 340
60 - 64	15	2	13	28	- 95	67	- 873	509	- 364	- 151	- 172	- 323
65 - 69	28	3	25	169	- 10	179	- 323	292	31	-	- 241	- 264
70+	307	101	408	3,283	357	3,640	1,240	1,287	2,527	548	- 359	189
Total 10+	-22,704	5,703	-16,999	-36,664	22,034	-14,630	-55,079	72,337	17,258	-25,888	8,074	-17,814

TABLE 1.—Continued

Age in 1961	Saskatchewan			Alberta			British Columbia			Yukon and N.W.T.		
	In- born	Out- born	Net balance	In- born	Out- born	Net balance	In- born	Out- born	Net balance	In- born	Out- born	Net balance
MALES												
10 - 14	- 6,488	1,450	- 5,038	- 5,333	5,451	118	- 4,205	7,782	3,577	- 296	83	-213
15 - 19	- 4,227	447	- 3,780	- 2,542	3,355	813	- 1,824	4,390	2,566	- 58	65	7
20 - 24	- 7,956	1,260	- 6,696	- 3,563	6,560	2,997	- 2,602	5,772	3,170	- 66	751	685
25 - 29	- 8,775	1,391	- 7,384	- 3,570	7,600	4,030	- 2,260	6,546	4,286	- 66	703	637
30 - 34	- 4,820	718	- 4,102	- 1,767	4,329	2,562	- 1,106	4,567	3,461	- 45	18	- 63
35 - 39	- 3,257	90	- 3,167	- 1,697	2,544	847	- 1,629	2,830	1,201	- 45	226	-271
40 - 44	- 1,748	60	- 1,688	- 141	2,117	1,976	- 497	2,928	3,425	- 11	125	-136
45 - 49	- 1,012	- 112	- 1,124	- 202	1,451	1,249	- 295	2,929	3,224	- 4	75	- 71
50 - 54	- 633	- 361	- 994	- 733	540	- 193	- 521	1,253	732	- 39	27	- 66
55 - 59	- 68	- 360	- 428	- 256	301	45	- 164	675	511	- 66	67	-133
60 - 64	3	- 273	- 270	- 81	164	83	- 281	435	154	- 62	2	- 64
65 - 69	142	- 276	- 134	79	- 30	49	- 67	537	604	- 33	3	- 36
70+	412	250	662	253	775	1,028	615	1,648	2,263	- 31	52	- 33
Total, 10+	-38,427	4,284	-34,143	-19,553	35,157	15,604	-13,118	42,292	29,174	- 814	1,007	193
FEMALES												
10 - 14	- 6,342	1,371	- 4,971	- 5,093	4,998	- 95	- 4,004	7,589	3,585	- 280	96	-184
15 - 19	- 4,576	295	- 4,281	- 2,413	3,235	822	- 1,697	3,767	2,070	- 99	12	- 87
20 - 24	- 9,074	926	- 8,148	- 4,040	7,027	2,987	- 2,968	5,280	2,312	- 115	395	280
25 - 29	-10,044	1,405	- 8,639	- 4,652	7,550	2,898	- 3,264	6,413	3,149	- 109	576	467
30 - 34	- 5,525	812	- 4,713	- 3,053	4,774	1,721	- 2,139	4,825	2,686	- 75	331	256
35 - 39	- 3,260	106	- 3,154	- 2,161	2,391	230	- 1,749	2,454	705	- 62	37	- 99
40 - 44	- 1,408	46	- 1,362	- 279	1,974	1,695	- 461	2,857	3,318	- 5	34	- 39
45 - 49	- 1,104	- 159	- 1,263	- 157	1,281	1,124	- 350	2,564	2,914	- 31	12	- 43
50 - 54	- 667	- 485	- 1,152	- 751	388	- 363	- 640	726	86	- 50	2	- 48
55 - 59	- 177	- 315	- 492	- 257	226	- 31	- 190	767	577	- 58	12	- 46
60 - 64	- 34	- 359	- 393	- 132	86	- 46	- 202	642	440	- 54	2	- 56
65 - 69	90	- 426	- 336	--	8	8	38	610	648	- 38	11	- 49
70+	296	239	535	85	852	937	396	1,927	2,323	- 38	4	- 42
Total, 10+	-41,825	3,456	-38,369	-22,903	34,790	11,887	-15,608	40,421	24,813	-1,014	1,324	310

Source: George, 1970, Appendix Table A.1.

previous section, survival ratios of in-born population of a province are applied to the in-born population enumerated there and elsewhere. Consequently, different survival ratios are applied to the lifetime non-migrant and the lifetime in-migrant components of the population enumerated in the province. An alternate procedure to the one employed here is to apply survival ratios of the in-born population to (i) the population born in and residing in the given province at the census date and (ii) the population born elsewhere and residing in the given province at the same date (Burch, 1962; Elizaga, 1965, pp. 76-106). In this procedure the assumption is that the survival ratios of the in-born population are applicable to the entire resident population of an area. From a practical point of view such a procedure can be justified; but the main objection to it is that only the component of in-born population enumerated in the same area or province of birth gets its proper survival ratio. As stated by Eldridge and Kim (1968, pp. 8-9), "The entire migrant population ("migrant" in the sense of their living outside their area of birth) gets the "wrong" survival ratio, that is, a survival ratio to which they have not contributed, the ratio of a closed population to which they do not belong."

The effect of the two estimation procedures could be found only in the net migration estimates of the out-born population and in the net balance of migration which is the sum of net migration among in-born and out-born. Estimates of net migration using the two procedures were prepared and compared for 1951-61; a summary comparison of the results is shown in Table 2 (procedure A was used in the present study and B refers to the alternative procedure).

Except for Alberta, British Columbia and Yukon and Northwest Territories, the relative deviations between procedures A and B are small, ranging from

TABLE 2.—Comparison of Estimation Procedure A Used in Present Study with B, an Alternative Described in Text, with Respect to Net Migration

Province	Net migration, total, by procedure		Pct. dev.
	A	B	
Newfoundland . . .	-13,863	-13,872	- 0.1
Pr. Edward Is. . .	- 9,987	- 9,928	0.6
Nova Scotia. . .	-36,070	-36,021	0.1
New Brunswick. .	-30,712	-30,327	1.3
Quebec	-26,288	-26,586	- 1.1
Ontario.	29,301	28,876	- 1.4
Manitoba	-31,556	-32,619	- 3.4
Saskatchewan . .	-72,510	-71,837	0.9
Alberta.	27,494	20,426	-25.7
Brit. Columbia	53,992	34,829	-35.5
Yukon & N.W.T.	507	696	37.3

0.1 to 3.4 per cent; the deviation for the Territories can be discounted because of the small numbers there. The high percentage deviations in Alberta and British Columbia were the result of two factors: (i) the comparatively high proportion of out-born persons there, and (ii) the relatively low death rates in the two provinces. In 1966, for example, when the age-adjusted death rate for Canada was 7.2 per 1,000 population, the corresponding rates for Alberta and British Columbia were 6.7 and 6.9 respectively (DBS, *Vital Statistics*, 1966, p. 106), the second and fourth lowest rates among the provinces.

Examination of the migration estimates by age shows that the relative differences are larger at the older ages. Similar results were observed in a recent study for the United States using division of birth residence data (Eldridge and Kim, 1968, pp. 12 and 13). The relative differences by age also show that Alberta and British Columbia had the highest differences between the two series of estimates.

If procedure A is accepted as the better of the two, it may be concluded from the foregoing findings that in most cases procedure B can be relied upon for estimating interprovincial total decade net migration 10 years of age and over, and for five-year groups under age 50.

5. COMPARISON OF INTERCENSAL MIGRATION ESTIMATES FOR THE CANADIAN-BORN POPULATION CALCULATED BY DIFFERENT METHODS

The purpose of this comparison is to examine the relative accuracy of intercensal net migration estimates calculated by three methods using three sets of survival ratios: (i) the place of birth survival ratios (PBSR); (ii) the census survival ratios (CSR) and (iii) the life table survival ratios (LTSR).

The main problem in estimating migration by the census survival ratio method is to achieve a "closed population" for Canada which is the theoretical requirement to calculate the national census survival ratios. A reasonably closed population of the native born was obtained by the inclusion of the Canadian-born population enumerated in the censuses of the United States with the corresponding numbers enumerated in the Canadian censuses. Using the estimated Canadian-born population for 1951 and 1961, ten-year forward survival ratios for the Canadian-born population, 1951-1961 were calculated. These ratios along with the regional life table survival ratios for the same period (calculated from the average values of the life tables 1950-52 and 1960-62 (L_x) for the total population) have been published (George, 1970, Tables 3.4 and 3.6).

The fluctuations in census survival ratios and for ratios greater than unity in some age groups may be due to such factors as under-enumeration or over-enumeration, errors in reporting age, either at the initial or at the terminal year, and errors in the adjustment of the census age data for international migration. Despite the limitations of the census survival ratios they are generally preferred for estimating intercensal net migration using census age distributions. The merits of using census survival ra-

tios compared with life table survival ratios, and the main assumption on enumeration errors involved in the application of national census survival ratios to provincial age data have been demonstrated by many scholars in the field of migration (Hamilton and Henderson, 1944, p. 200; Price, 1955; Lee, 1957, p. 26; Zachariah, 1962, pp. 175-183; Hamilton, 1966, pp. 404-414; Sivamurthy, 1969). Applying the census and life table survival ratios described above, separate sets of intercensal net migration estimates were prepared for each of the provinces. It may be noted that the estimates of interprovincial net migration for the Canadian born prepared by the three methods include migration between Canada and the United States. In order to separate this component in estimating migration by the PBSR method, the Canadian-born population enumerated in the United States would have to be distributed according to the province of birth and residence by age and sex for each province. Because of the laborious computations involved, it was decided not to separate the migration between Canada and the United States.

The total net migration in each province by the three methods and the index of deviation are presented in Table 3. As expected, the results show that PBSR and CSR estimates are closer than CSR and LTSR estimates. The same picture can be seen in the migration estimates by age as well. The age-specific migration rates for males calculated from the three sets using the average cohort population as the base are presented in Chart 1. The most striking finding from Chart 1 is that the net migration curves by age obtained by CSR and PBSR methods are smoother than the curves obtained by the use of the more accurate life table survival ratios (for similar results, see Hamilton and Henderson, 1944, pp. 197-206).

In order to understand the reasons for the differences between the three sets of

TABLE 3.—Interprovincial Net Migration Estimates from Place of Birth Survival Ratios, Census Survival Ratios, and Regional Life Table Survival Ratios for Canadian Born Aged 10 and Over, by Sex, 1951-61

Province	PBSR (1)	CSR (2)	LTSR (3)	Index of deviation	
				(1)/(2) (4)	(3)/(2) (5)
MALES					
Newfoundland .	- 6,029	- 6,206	- 4,002	0.97148	0.64486
Pr. Edward Is.	- 4,708	- 5,408	- 4,877	0.87056	0.90181
Nova Scotia. .	-16,172	-17,924	-14,296	0.90225	0.79859
New Brunswick.	-13,713	-16,955	-14,073	0.80879	0.83002
Quebec	-11,654	-12,112	23,303	0.96219	-1.92396
Ontario. . . .	12,047	6,954	39,612	1.73238	5.69629
Manitoba . . .	-13,738	-15,066	-11,932	0.91185	0.79198
Saskatchewan .	-34,143	-35,478	-32,037	0.96237	0.90301
Alberta. . . .	15,604	19,860	23,957	0.78570	1.20629
Brit. Columbia	29,174	37,409	44,171	0.77986	1.18076
Yukon & N.W.T.	193	138	378	1.39855	2.73913
Canada	-43,139	-44,788	50,204	0.96318	-1.12093
FEMALES					
Newfoundland .	- 7,840	-10,724	- 8,413	0.73107	0.78450
Pr. Edward Is.	- 5,277	- 6,145	- 5,512	0.85875	0.89699
Nova Scotia. .	-19,897	-23,210	-19,279	0.85726	0.83063
New Brunswick.	-17,001	-23,112	-19,814	0.73559	0.85730
Quebec	-14,630	-19,828	13,195	0.73784	-0.66547
Ontario. . . .	17,258	21,441	45,453	0.80491	2.11991
Manitoba . . .	-17,814	-19,415	-16,567	0.91754	0.85331
Saskatchewan .	-38,369	-39,410	-36,231	0.97358	0.91934
Alberta. . . .	11,887	16,139	19,816	0.73654	1.22783
Brit. Columbia	24,813	33,649	37,927	0.73741	1.12714
Yukon & N.W.T.	310	298	436	1.04027	1.46309
Canada	-66,551	-70,317	11,011	0.94644	-0.15659

Source: George, 1970, Table 3.5 for PBSR and CSR. LTSR, see text.

estimates and to assess the relative reliability of each, the major factors that create these differences may be examined. If there were no errors in the age and place of birth data used, and the survival ratios were exact, the estimates from all three methods should be identical. This is because estimates of intercensal net migration from the three methods give only the net migration among those living to the end of the intercensal period. The divergence in the results suggests errors in the data and limitations of the methods used for correcting errors in basic data. The main factors that may affect the estimates are: (i) under-enumeration or over-enumeration of the population; (ii) misstatement of age and/or place of birth; (iii) international migration; and (iv) application of incorrect survival ratios.

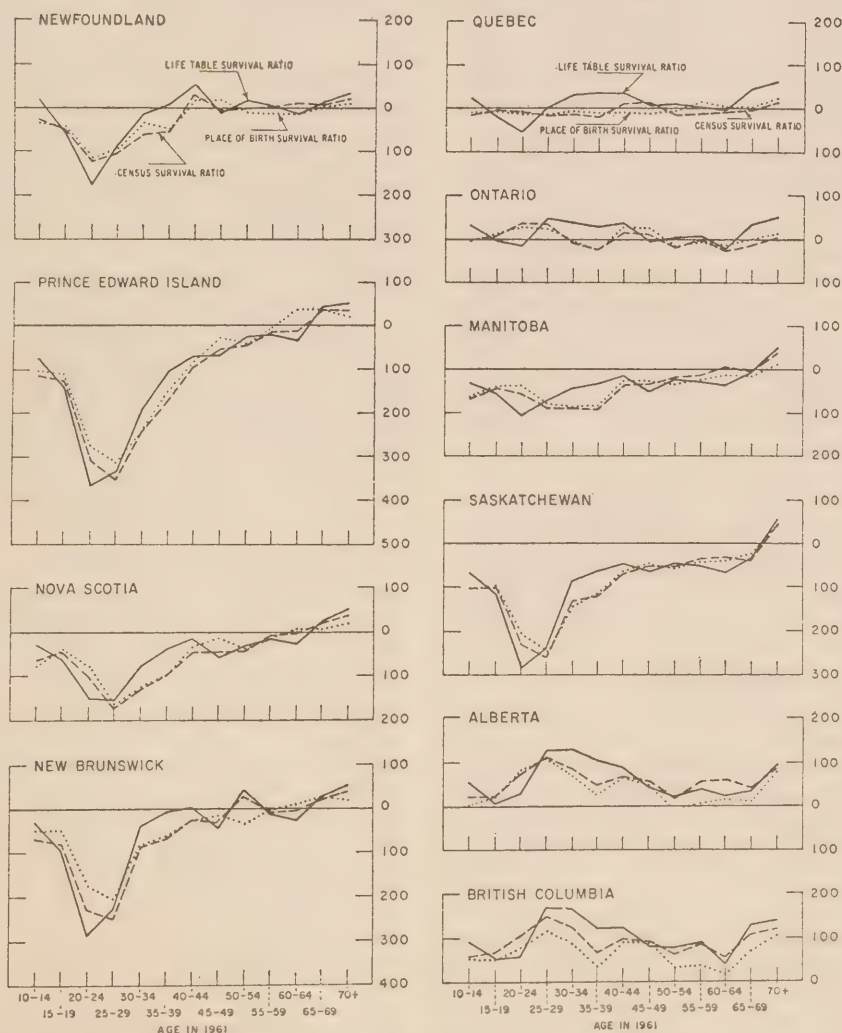
Errors in the basic data affect all three

sets of intercensal estimates and their effect depends on the variation of enumeration errors in the two censuses. One of the assumptions involved in the application of census survival ratio method is that to obtain migration estimates free from enumeration errors, "the ratio of the degree of enumeration in any age-sex group in a state (i.e., the proportion which the enumerated population in any age-sex group bears to the true population) to that of the nation" should be equal for the same age-sex cohort in both the censuses (Zachariah, 1962, p. 177). The available information on the quality of census data suggests that Canadian censuses have been of varying quality and that the proportionate enumeration errors are of unequal magnitude in the different censuses. Therefore, it is unlikely that this assumption will be fully valid in the estimates made here.

However, under this assumption the amount of migration and the error components will be separated; and the estimated amount of migration will be independent of the error in the first census. As a consequence, when the amount of migration is divided by the population at the second census, it is possible to get

a migration rate free from enumeration errors. The reason for this is that the percentage error in the migration estimate would be equal to the percentage error of enumeration in the population at the second census (for proof, see Zachariah, 1964, p. 149). It also permits the obtaining of net migration estimates

CHART 4.- RATES OF INTERPROVINCIAL NET MIGRATION AS ESTIMATED BY THE CSR, PBSR AND LTR METHODS FOR CANADIAN-BORN MALES 10 YEARS OLD AND OVER, BY AGE, PROVINCES, 1951-1961
(RATE PER 1,000 AVERAGE CANADIAN BORN POPULATION OF APPROPRIATE AGE)



Source: George, 1970, Appendix Table A.2 for PBSR rates; other rates were obtained as discussed in Section 5

above age 10 free from the effect of enumeration errors under age 10 which are common in census enumerations. The effect of enumeration errors is likely to be more if migration estimates are made by the LTSR method than if they are by the CSR and PBSR methods because of the application of fairly correct survival ratios to incorrect population data. The effect of misstatement is likely to be different for CSR and PBSR estimates. If a person born in another province is reported as being born in the province of enumeration, he will not be counted as a lifetime migrant. On the other hand, if the age of a migrant (a person residing outside the province of birth) is misreported, he will appear in another age in the PBSR estimate. This is not possible by the CSR method. If the age misreporting of the population is not of the same type and magnitude in the provinces and the country as a whole, the error from this source in the migration estimates by the CSR method can be substantial. By the LTSR method, any defect in the reported age distribution will have its full effect on the estimates, and there is no possibility for cancellation of this error.

In the present case errors in the estimates of international migration will affect only the migration estimates by the PBSR and CSR methods. For, in the LTSR method the survival ratios applied are independent of the effect of international migration. The estimates by the PBSR method will be subjected to errors in the estimation of the number of Canadian-born emigrants by age, and in the allocation of this number by province of origin. The estimates by the CSR method are affected only by the former type of error.

Because separate survival ratios for each province or region have been applied in the case of PBSR and LTSR methods, migration estimates by these methods will be practically free from the effect of differences of mortality level

and pattern in the provinces. However, it may be noted that the life table survival ratios used are derived from the life tables for the total population (Canadian born and foreign born together) and not solely for the Canadian-born population as required in the present case. The available data on mortality for the Canadian born and foreign born indicate significant differences in the death rates between the two groups (George, 1970, C. III).

Although it is difficult to prove conclusively the superiority of one method over the other for estimating intercensal net migration in Canada, the preceding discussion and the comparison of the three sets of estimates suggest that the net migration estimates for the Canadian born by the PBSR method are probably more reliable than those by the other two methods. Judging from the methodology, the data used and the consistency of the results, the second best is the set of estimates by the CSR method. The main difference between the PBSR method and the CSR method lies in the use of different sets of survival ratios; provincial survival ratios were used in the PBSR method and national census survival ratios in the CSR method. Further, whatever the relative accuracy of the estimates by the PBSR method, it provides more details about the net migration of the native born than those by the other two methods. Thus, it is possible to estimate separately for each province (i) net gains or losses due to migration of persons who were born in the same province and (ii) net gains or losses due to the migration of persons born elsewhere in the country. Also, it is possible to get detailed data by the PBSR method for studying individual intercensal migration streams between provinces.

The sum of the net migration for all the provinces together should have yielded a zero balance for Canada. This did not occur in the estimates made here

by the three methods because of the effect of external migration. The net balance for Canada as a whole represents the net migration between Canada and other countries, mainly between Canada and the United States during the decade. The PBSR method estimated a loss of 43,139 males and 66,551 females, among the Canadian-born population during 1951-1961, while the CSR estimated a loss of 44,788 males and 70,317 females. Most persons probably migrated to the United States. When the estimates by the CSR method were made after distributing the estimated Canadian-born population in the United States in 1951 and 1961 by province of origin, the balance for Canada was reduced to almost zero for both sexes. Thus, the net migration estimates given in Tables 1 and 3 include migration between Canada and the United States as well. By applying the provincial survival ratios (George, 1970, Table 3.3) to the Canadian-born population enumerated in the United States by age and sex in each province of origin, separate net migration estimates between Canada and the United States could be prepared for each province.

6. ADDITIONAL COMMENTS ON ESTIMATES OF NET INTERPROVINCIAL MIGRATION

The relative merits of the migration estimates by the place of birth survival ratio method over the CSR and LTSR methods are discussed in the preceding section where it is shown that the level and pattern of migration estimates by the PBSR method were closer to those by the CSR method than to the estimates by the LTSR method (see Chart 1). Whatever relative superiority the PBSR method has, the differences between the estimates at the advanced ages should be interpreted with great caution because demographic data for persons in the advanced ages are generally rather poor. Of the advanced ages, the

estimates for the open-age interval 70 years and over are likely to be the most unreliable. Despite the relative merits of migration estimates by the PBSR method, it may be noted that the estimates should not be taken as an exact measurement of net migration, but rather as an indication of the dimension of the movements of the population.

For the sake of convenience, the detailed net migration estimates by age and sex for each province of births originally computed are rearranged and are presented in Table 1. The table gives for each province (i) the decade net migration of its own in-born population with respect to all other provinces together, i.e., mostly total "net out-migration"; (ii) the decade net migration of its own out-born population i.e., mostly "net in-migration"; and (iii) the "net balance of migration" which is the sum of net in-migration and net out-migration. Thus, for Ontario the numbers under "net migration of in-born" represent *mostly* the total net interprovincial out-migration from that province to all other provinces together, the numbers under "net migration of out-born" represent *mostly* the total in-migration to Ontario from all other provinces together and the numbers under "net balance of migration" represent the sums of the net in-migration and out-migration (for details see George, 1970, Table A.1). The positive signs against the net migration of the in-born and the negative signs against the net migration of the out-born indicate the effect of return and secondary migration (See Eldridge, 1965b, pp. 444-455).

It should be noted that the migration estimates prepared and discussed in this paper relate to Canadian-born population only. Interprovincial net migration estimates for the foreign-born population were separately prepared elsewhere by the census survival ratio method, using census survival ratios for the native born adjusted for mortality differences between the native born and for-

eign born (for details see George, 1970, C. III). The sum of net migration of the Canadian born and foreign born would give the total net migration for each province.

7. NET MIGRATION AMONG PERSONS UNDER 10 YEARS OF AGE

The three methods of estimating intercensal migration, by age, yield estimates only for the population aged 10 and over on the terminal census date (that is, persons who were enumerated in the first census and survived to the second census and not those born during the intercensal period). Hence, separate net migration estimates were directly derived for population under age 10 from the place of birth and residence distributions, by age. For this group "life-time" migration is the intercensal migration (see Eldridge and Kim, 1968, p. 7). Therefore, intercensal net migration estimates for the group under age 10 were directly derived from the place of birth by residence data. The results are given in Table 4.

8. SUMMARY AND CONCLUSION

Statistics of persons classified jointly by place of birth and residence and tabulated by age and sex for successive censuses are seldom available to make full use of place of birth data. In Canada, unlike many other countries, such data are available in each of the decennial censuses from 1931 to 1961 which

permit the estimation of intercensal net migration by age and sex for provinces and regions. In this paper the problems and procedures in estimating intercensal migration for Canada, 1951-1961 using "place of birth survival ratio method" are discussed with a comparison of estimates with other estimates based on survival ratios for the same period.

Examination of the various types of "errors" in estimating intercensal net migration by simply subtracting place of birth information from the earlier census from that for the later census showed that the most serious error associated with this procedure was caused by mortality.

Assuming that the native-born population of Canada including those enumerated in the United States is reasonably "closed," provincial intercensal age-specific survival ratios for the population born in a province (in-born) were calculated for 1951-1961. By applying these survival ratios to the population born in a province and residing there and in each of the other provinces in 1951, expected numbers of this population for 1961 were obtained. The difference between the expected numbers and the corresponding numbers enumerated in 1961 gave estimates of net change due to the intercensal migration of the population born in each province with reference to each of the provinces.

The comparison of net migration estimates for the Canadian-born population obtained by the place of birth survival ratio method (PBSR) with those by the census survival ratio (CSR) and life table survival ratio (LTSR) methods showed that the former two estimates were closer than CSR and LTSR estimates. The most striking finding was that the net migration curves by age obtained from the CSR and PBSR estimates were smoother than the curve obtained with the use of the more accurate life table survival ratios. The comparison also

TABLE 4.—Net Interprovincial Migration of the Canadian Born Aged 0-9, 1951-61

Province	Male	Female
Newfoundland . . .	- 450	- 362
Pr. Edward Is. . .	- 220	- 203
Nova Scotia. . .	-2,659	-2,414
New Brunswick. . .	-1,432	- 963
Quebec	868	919
Ontario.	3,622	3,556
Manitoba	-2,986	-3,152
Saskatchewan . . .	-5,360	-5,215
Alberta.	2,136	1,988
Brit. Columbia . .	6,383	5,801
Yukon & N.W.T. . .	98	45

Source: George, 1970, Table 3.7.

suggested that the net migration estimates by the PBSR method were probably more reliable than the other two sets. Further, whatever be the relative accuracy of the estimates by the PBSR method, it provides more details about the net migration of the native born than by the other two methods.

Separate estimates of net migration for the population under age 10 were directly derived from the place of birth and residence distributions by age. For this group the "lifetime" migration or "birth residence index" is the intercensal net migration.

ACKNOWLEDGMENTS

This paper, prepared for the 1970 meetings of the Population Association of America in Atlanta, is based on the results of some exploratory work done in connection with the author's recent monograph, *Internal Migration in Canada: Demographic Analyses*. The author is grateful for the assistance of the staff of the Research Sub-Division, Census Division in the preparation of the paper. The author is, however, solely responsible for the views expressed in this paper and for any blemishes of errors or faulty judgement that may appear therein.

REFERENCES

- Burch, Thomas K. 1962. Internal Migration in Venezuela. Unpublished Ph.D. dissertation, Princeton University.
- Canada, Dominion Bureau of Statistics. 1968. Vital Statistics, 1966. Ottawa: Queen's Printer.
- Eldridge, Hope T. 1965a. Net Intercensal Migration for States and Geographic Divisions of the United States, 1950-60: Methodological and Substantive Aspects. Philadelphia: Population Studies Center, University of Pennsylvania.
- . 1965b. Primary, secondary, and return migration in the United States. *Demography* 2:444-455.
- and Yun Kim. 1968. The Estimation of Intercensal Migration from Birth Residence Statistics: A Study of Data for the United States, 1950-1960. Philadelphia: Population Studies Center, University of Pennsylvania.
- Elizaga, Juan C. 1965. Assessment of migration data in Latin America. *Milbank Memorial Fund Quarterly* 43:76-106.
- George, M. V. 1965. Internal Migration in Assam and Bengal, 1901-1961. Unpublished Ph.D. dissertation, Department of Demography, The Australian National University, Canberra.
- . 1970. Internal Migration in Canada: Demographic Analyses. 1961 Census Monograph, Dominion Bureau of Statistics. Ottawa: Queen's Printer.
- Hamilton, C. Horace, and F. M. Henderson. 1944. Use of the survival rate method in measuring net migration. *Journal of the American Statistical Association* 39:197-206.
- . 1966. Effect of census errors on the measurement of net migration. *Demography* 3:393-415.
- Kasahara, Y. 1963. The flow of migration among the provinces in Canada, 1951-1961. In W. C. Hood and J. A. Sawyer, eds., *CPSA Conference on Statistics, 1961 Papers*. Toronto: University of Toronto Press.
- Keyfitz, Nathan. 1950. The growth of Canadian population. *Population Studies* 4:47-63.
- Lee, Everett S., et al. 1957. *Population Redistribution and Economic Growth, United States, 1870-1950*. Vol. 1. Philadelphia: The American Philosophical Society.
- Price, Daniel O. 1955. Examination of two sources of error in the estimation of net internal migration. *Journal of the American Statistical Association* 50:689-700.
- Shryock, H. S., Jr. 1964. *Population Mobility Within the United States*. Chicago: Community and Family Study Center, University of Chicago.
- Sivamurthy, M. 1969. Errors in the estimation of net migration rate in the studies of internal migration. *Journal of the American Statistical Association* 64:1434-1438.
- Zachariah, K. C. 1962. A note on the census survival ratio method of estimating net migration. *Journal of the American Statistical Association* 57:175-183.
- . 1964. *A Historical Study of Internal Migration in the Indian Sub-Continent, 1901-1931*. Bombay: Asia Publishing House.

CENSUS DIVISION PAPERS AND MEMORANDA ISSUED

Reprinted Publications

Census Technical Papers

Technical Memoranda (1965-1968)

Analytical and Technical Memoranda (since 1969)

Lists of papers published in above series are available from:

Technical Co-ordinator (Research)
Census Division
Statistics Canada
Ottawa, Ontario
K1A 0T7

